

REMARKS

The Office Action of May 13, 2010, has been carefully studied. Including withdrawn claims, claims 1-20, 24-35 and 38-43 currently appear in this application. These claims define novel and unobvious subject matter under Sections 102 and 103 of 35 U.S.C., and therefore should be allowed. Applicant respectfully requests favorable reconsideration and formal allowance of the claims.

Claim Amendments

The claims have been amended to recite more positively that the compounds claimed herein are quasi-amorphous compounds. Support for these amendments can be found in the specification as filed at pages 5 through 10, in which quasi-amorphous compounds are defined and their production explained. New claims 42 and 43 are supported by the specification as filed at page 3, lines 21-27.

Art Rejections

Claims 1, 5-20, 24-30 and 41 are rejected under 35 U.S.C. 102(b) as anticipated by or, in the alternative, under 35 U.S.C. 103(a) as obvious over MacKenzie et al., US 5,342,648.

This rejection is respectfully traversed.

MacKenzie discloses amorphous compounds which are ferroelectric. The herein claimed compounds are quasi-amorphous and are

pyroelectric and piezoelectric. Figure 1 of MacKenzie is an exact description of what is a ferroelectric material. As is clearly shown in Figure 1 of MacKenzie, in the hysteresis loop, the direction of polarization is reversed as the applied electric field is reversed.

In contrast thereto, pyroelectric materials, including the compounds claimed herein, do not possess polarization reversal. Clearly, the MacKenzie amorphous compounds are physically different from the quasi-amorphous compounds claimed herein.

It is clear that MacKenzie only discloses amorphous compounds. The compounds of MacKenzie are made by conventional sol-gel process and are heated at temperatures below the temperature at which crystallization may occur (Abstract). All of the compounds in MacKenzie are characterized as being amorphous. At column 8, lines 30-39, MacKenzie states:

That the ferroelectric material was amorphous was confirmed by X-ray diffraction and electron diffraction. An electron diffraction patterns shows only diffuse rings. The observable limit of crystalline size in the X-ray diffraction is approximately 100 Angstroms, while that of electron diffraction was 20 Angstroms. No crystallites were observed. Both of these tests indicate the basically amorphous nature of the film. If there were any small crystallites, they were necessarily smaller than 20 Angstroms.

It can be clearly seen from the above that the MacKenzie compounds are amorphous compounds to which no stress has been applied, causing any change in their amorphous structure.

The presently claimed quasi-amorphous compounds, however, are not the same as the compounds disclosed in MacKenzie. The present specification, at page 4, lines 1-3, defines quasi amorphous compounds as compounds which are non-crystalline ionic solids having a macroscopic polarization. The pyroelectric properties are imparted to the compounds by applying a mechanical strain, such as a steep temperature gradient or an electric field, to the substantially amorphous compounds. While the compounds before such treatment are substantially amorphous, the mechanical strain imparted to the compounds creates macroscopic polarization within the compounds, while preventing the formation of crystals. This polarization produces the pyroelectric properties, thus making the compounds quasi-amorphous. The process to which the amorphous compounds are subjected causes them to be quasi-amorphous, and thus different from the original amorphous compounds.

As the present specification describes in the last paragraph on page 4, the quasi-amorphous compounds claimed herein have a relatively low dielectric constant and a relatively high pyroelectricity. These compounds have the advantageous features of amorphous compounds (e.g., low dielectric constant, low production costs) as well as the advantageous features of crystalline compounds (e.g., pyroelectricity and piezoelectricity). The pyroelectric and piezoelectric properties of the quasi-amorphous compounds may be attributed to a spontaneous local dipole ordering, which is usually observed in crystalline solids but not in amorphous solids. The pyroelectric

effect is obtained because of the macroscopic polarization within the quasi-amorphous compound.

The mechanical strain applied to the amorphous compounds to form quasi-amorphous compounds is applied so as to impart macroscopic polarization within the compound and to prevent the formation of crystals. There is nothing in MacKenzie about processing the amorphous compounds to impart macroscopic polarization. MacKenzie merely discloses that the compounds are amorphous, and does not teach or suggest any further processing of the compounds. The herein claimed compounds, which have been subjected to a strain, have an alignment of local dipoles of the molecules, forming a macroscopic dipole moment. This is not the case for the MacKenzie compounds.

The method by which the presently claimed quasi-amorphous compounds are produced makes it possible to produce a large in-phase compressive stress ensuring that the motifs cannot change their orientation. As explained at page 10, lines 10-13, when the volume expansion is restricted, nucleation is suppressed. The films passed through the temperature gradient developed a high in-plane compressive stress of 2.0-2.2 GPa.

MacKenzie only discloses that his amorphous materials, which are **not** subjected to a mechanical strain, are **ferroelectric**, not pyroelectric, as are the quasi-amorphous materials claimed herein, which are pyroelectric. As noted above, the basic difference between pyroelectric materials and ferroelectric

materials is that in ferroelectric materials, the direction of the polarization is reversed as the applied electric field is reversed. Pyroelectric materials do not possess polarization reversal.

Moreover, MacKenzie does not teach how to use amorphous compounds to create therefrom piezoelectric/electrostrictive properties while preventing crystallization of the ceramics. Poling, that is, applying mechanical force to an inorganic material in order to provide pyroelectric and piezoelectric properties is not a trivial issue because of the lack of spatial periodicity inherent to ionic crystals (see example page 4, lines 16-25).

As disclosed in the background section of MacKenzie, "It has now been discovered that stable ferroelectricity can be produced in amorphous material formed by a modified sol-gel technique. The ferroelectric effect has not only been found in mixed metal oxides known to be ferroelectric in their crystalline state, but also in certain single metal oxides never previously known to be ferroelectric. The materials are stabilized, for example, by heating so that stable ferroelectric properties persist during use of the films."

MacKenzie forms an amorphous ferroelectric material by preparing a liquid solution containing at least one precursor compound for the ferroelectric material. No mechanical strain is applied during the preparation of the amorphous material.

Moreover, MacKenzie fails to teach any technique relating to an amorphous compound in which a mechanical strain is controlled so as to prevent crystallization of an inorganic compound, yet imparts macroscopic polarization. The mechanical strain in MacKenzie, poling and electric field, is not applied to the amorphous ferroelectric material to prevent crystallization and to produce pyroelectric properties. In MacKenzie, the amorphous ferroelectric material is used as a precursor and is cooled in a D.C. electric field to verify that the sample has ferroelectric properties, not to create ferroelectric properties.

Therefore, it is clear that MacKenzie does not teach applying a mechanical strain such as a temperature gradient to generate a gradient of mechanical strain within an amorphous material.

The compounds of the present invention have pyroelectric properties, which properties are created by stress induced dipole ordering. In the present case, the process of making the quasi-amorphous compounds, by imposing a mechanical strain on the compounds, does indeed produce compounds which are different from those of MacKenzie.

Claims 31-35 are rejected under 35 U.S.C. 103(a) as being unpatentable over MacKenzie.

This rejection, as well as it can be understood, is respectfully traversed.

Since claims 31-35 depend from claim 1, which is believed to be patentable over MacKenzie, it is respectfully submitted that claims 31-35 should also be patentable.

With respect to Mori, it should be noted that Mori applies an electrical field to compounds that are already in a crystal form and does not relate to amorphous compound.

State of the Art

It is noted that the prior art made of record and not relied upon is merely considered pertinent to applicant's disclosure.

In view of the above, it is respectfully submitted that the claims are now in condition for allowance, and favorable action thereon is earnestly solicited.

Respectfully submitted,

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